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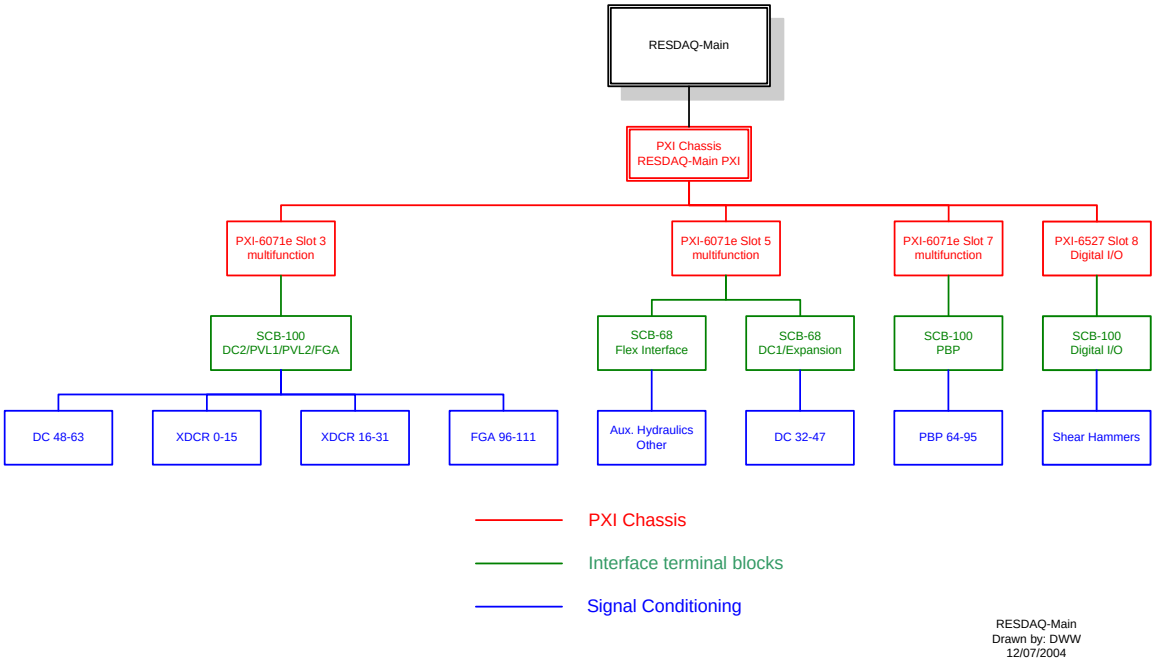
This Document

The purposes of this document are to introduce new users to resources available and to present experienced users with a convenient reference to the equipment and software they are using. It is not sufficient to train new users without hands-on interaction.

RESDAQ-Main

RESDAQ-Main is a Windows based PC mounted onboard the centrifuge. The computer hardware and software represents the core functionality for performing experiments on the centrifuge at UC Davis. The hardware in RESDAQ-Main is listed in the diagram below.



Software Library:

Users will typically use the following programs during their experiments. Many smaller programs also exist for performing miscellaneous tasks and are only used on an as-needed basis. These other programs are self-documented.

RESDAQ (ver. 11_09_04):

This program will sample data from one to three multifunction devices in the local computer. The program can sample data at moderate to high speeds, depending on channel count. The devices share a common source clock so that all data is synchronized. This program is used for:

- Slow data during spin up / spin down, or during calibration
- Fast data during simulated seismic events
- Very fast data when measuring shear wave velocities using air piston sources and accelerometer receivers.

The source code resides on the data acquisition server at the Center for Geotechnical Modeling. Any computer with National Instruments Labview ver. 7.0 and NI-DAQmx installed and configured can run the program. A multifunction DAQ card must also be installed and configured for the program to capture data.

Starting the program:

Prior to running the program a user must have a preconfigured channel list for each device from which they plan to sample data.

Press the white run button at the top of the screen to execute the program. The user will immediately be asked to “save static data.” While the program samples data at high sampling rates, the data will also be averaged and the averages logged to disk. By convention, files are stored in C:\Data\(project name) and have an extension of .bin.

The user will be offered a header area. Information typed into this header region will be inserted into the logged data file headers as necessary metadata.

The user is asked how many devices will be sampled. A list of devices and attached instrumentation are offered. This list is valid only for RESDAQ-Main. Note the RESDAQ program can be used on other computers. In this case the user must be aware of the device configurations for the computer they are using. The user will select the number of active devices. The user will then be prompted to enter a channel list for each active device.

Note the first device selected will become the “master device.” If the user plans to perform analog output with any one of the devices while sampling, for example to command the auxiliary actuators, then the user must chose the device with the analog output source as the first, or master, device.

The user will then be asked to chose a sampling rate and save rate. The sampling rate will set how fast the ADC will sample data. This rate is set once when the program starts, and cannot be changed without restarting the program. The save rate is how often static data is logged to disk. The save rate can be changed at any time while the program is running.

The User Interface:

The most prominent feature of the user interface is the large graph. The graph is used to monitor the high speed response of any single channel. The graph is updated with the save rate, so if the user sets the save rate at one second, then one second of high speed data will be displayed on the graph at a time.

In order to activate the graph, the user must press the show graph button. Showing the graph requires resources from the computer. It is recommended that the user not show the graph during very high speed acquisition, such as when measuring shear wave velocities.

Below the graph there is a “Y Index” box. The number in this box selects the channel currently being displayed on the graph from the cumulative list of channels from all devices. The “Y label” box displays the global channel name for the channel currently being displayed. Similarly, the “Y average” box displays the mean value of the current snapshot.

The user can chose to plot the Y index versus time or versus another channel index by moving the toggle below the Y index boxes. The “X index” selects the channel number to use, while the “X label” displays the global channel name.

When the user wants to log the fast data to file, they press the “Save data” button. Once this button is pressed and the green light next to it turns on, then the high speed data is being logged directly to disk in addition to the averaging and logging of static data. Each time the button is pressed a new data file is generated. The filename is generated by appending the current time to the file name of the static data file.

The user can also choose to decimate the high speed data before logging it to disk. Decimating the data will average several points and log the average value rather than logging each point. Note that the fast sampling rate divided by the decimating factor must be an integer or the time logged in the data file will be wrong.

Finally, the user can change the save rate, or the rate at which data is averaged and logged to disk. Elapsed time and centrifuge rpm are automatically appended to the sensor logs as the first two sensor recordings.

Note that the elapsed time represents how often the data is saved, which can vary from how often the average is actually taken. Users that require greater precision in time should use the decimate function and the save data button described above to log data continuously.

Stopping the program:

To stop the program press the large button labeled stop on the screen. Do not press the stop sign shaped red button near the top of the screen.

Command Aux. Hydraulics (one or two actuator command.vi):

This program will send an analog waveform to the Auxiliary Hydraulics servo controllers. The Auxiliary Hydraulics subsystem is described elsewhere. The program must be run from RESDAQ-Main.

This program description is not a complete training document for operating the Auxiliary Hydraulics subsystem. Users must work with Center staff to set up and use the hardware and software.

The Auxiliary Hydraulics subsystem must be configured correctly. There is potential for damaging equipment and experiments using this system. The user is cautioned to take great care running this program.

This program must be run in conjunction with two other programs, RESDAQ and PAUSE AO. PAUSE AO controls when the analog waveform is passed to the servo controllers. If this command program is run without PAUSE AO running then the actuators may move before the user intends. By default PAUSE AO will be true, which indicates this program cannot send commands to the servo controller. Note that the value of the DACs can change if the user uses another program or if the computer is restarted even though the PAUSE AO program is running.

RESDAQ must be running so that the user can monitor the actuator positions and the current computer commands. Note the first device selected when starting RESDAQ will become the “master device.” The user must chose the device with the analog output source as the first, or master, device when starting RESDAQ.

Running the program:

Before starting the program the user can change the value of “amp ratio” on the front panel. “Amp ratio” will scale the motion going to actuator 2 by a constant. A ratio of 1.0 will send the same command to actuator 1 and actuator 2. A ratio of 2 will command actuator 1 to move half the distance of actuator 2. By default the value is 1.0071 to account for a slight difference in calibration constants for the two feedback LVDTs.

If the program is not already running, press the white right arrow at the top of the Labview screen to start the program.

The user is first asked if RESDAQ and PAUSE AO are running. If they are not, the user can cancel, start these other programs, and restart this program.

The user can then select from a menu of waveform types. The waveform choices include sine, sawtooth (ramp up, step down), square, and triangle (ramp up and ramp down).

Next the user must set the waveform amplitude, frequency, number of cycles, and the number of points per cycle. Frequency will set the frequency of the waveform. The number of points per cycle is used to set how smooth the waveform is. The optimum number of points per cycle is a function of the frequency of the waveform and the dynamic response of the auxiliary hydraulics system. A slowly varying waveform should have more points per cycle so that the achieved motion is smoothly varying.

By combining waveform type, frequency, and number of cycles the user can achieve many loading functions. For example, by using a sawtooth or triangle waveform with ½ a cycle the user can ramp the actuators to a new position.

The user must then set the initial offset value for each actuator. The user should use RESDAQ to see what the current position feedback level is and use that as the initial value. If the user selects any value other than the current position feedback value then the actuators will jump when the command waveform is sent.

The user is then presented with a graph showing them the motion to be sent to the actuators. The user can accept the motion or cancel. Canceling will stop the program and the user will need to start over.

If the user chooses to accept the current motion by pressing OK, then the motion is sent to the DAC on the data acquisition card. The command is now armed and waiting for a signal to begin motion. The user should now bring up the RESDAQ monitoring screen and the PAUSE AO interface.

When the user is ready they must press the “save data” button on RESDAQ to begin logging continuous data. Then they change the “pause” button on PAUSE AO to false and motion will begin.

Toggling the “pause” button between true and false will pause the waveform going to the servo controllers and will thus pause the motion of the actuators.

The user can abort the current waveform at the current value by first pausing the waveform and then returning to the command program user interface and pressing the “stop” button.

COMMAND AUX. HYDRAULICS specifically does not zero the output before or after the program executes. The analog output will remain constant at the last commanded value until either the user sets the output (with this or other programs) or until RESDAQ-Main is restarted.

PAUSE AO:

This program is used to control when a command waveform is sent to the auxiliary hydraulic system. It can only be run from RESDAQ-Main. The program is described in more detail in the COMMAND AUX. HYDRAULICS section.

Shear Hammer control (vsh control.vi)

This program is used to fire any one of the four vacuum-powered shear hammer pistons. The user simply runs the program by pressing the Labview run button at the top of the screen. The user can select how many times the piston will fire and select the time delay between firing. The piston must be fired twice to complete one complete cycle of motion.

The program uses Windows system timers and a series of relays to move the piston. This combined with the physical response of the pistons means the timing of the input pulse is not tightly controlled. Thus the user should not assume a trigger time for the source wave but should use the travel time between two receive accelerometers.

Hardware Library

Detailed specifications of each hardware component can be found in the Center for Geotechnical Modeling's facility binders, an online archive of equipment documentation. Additional information may also be archived as printed manuals. This section of the user's manual will describe the basic functionality of the equipment and the logic of how it is used.

DAQ cards:

PXI-6071e: multifunction DAQ

RESDAQ-Main includes three PXI-6071e multifunction cards. Each of these cards supports up to 64 analog inputs, two analog output, and eight digital I/O lines. The analog inputs are mapped to the available signal conditioning units and global channel names are predefined in the DAQ configuration so that users can monitor channels following the names printed on the amplifiers. Note this is only valid if the amplifiers are plugged in to the predefined positions.

One card includes a few open input channels that can be configured for custom signal conditioning as required.

PXI-6527: Digital I/O

RESDAQ-Main includes a digital I/O card with solid state relay outputs and optically isolated inputs. This device is used for controlling switches, for example the shear wave hammers.

Signal Conditioning:

Several amplifier units are available for conditioning ICP accelerometers, linear potentiometers, strain gauge bridges, and various other sensor types. Each amplifier channel has a unique name.

DC32-47 & DC48-63:

These are two sixteen-channel amplifiers with signal conditioning for ICP type accelerometers. These are commonly referred to as the "decouple amps."

XDCR0-15 & XDCR16-31:

These are two sixteen-channel amplifiers with signal conditioning for strain gauges, etc. Users can select gain via front panel mounted selector knobs. These are commonly referred to as the PVL amps."

FGA96-111:

This is a sixteen-channel amplifier with signal conditioning for strain gauges, etc. The gain is fixed at approximately 100 on all channels. This is commonly referred to as the “fixed-gain amp.”

PBP64-95:

This is a bank of 32 channel differential inputs to one of the multifunction DAQ cards. Each channel includes +5Vdc, 0Vdc, and -5Vdc for exciting sensors s. Use these channels if you are supplying both a voltage and a voltage reference. Do not use these channels with linear potentiometers that are wired without a separate signal reference pin.

PBP64se-95se

This is the same physical bank of 32 channels as PBP64-95. For these channels, however, the software driver has been configured for single ended signals. Use these channels for linear potentiometers that are wired without a separate signal reference pin.

Servo controllers:

The center has two Parker Model 23-7030 servo control amplifiers and two servo valves.